was largely discredited because it suggested final causation or future outcomes directing earlier events, but maintained that the kind of purposeful behavior guided by feedback was sufficiently important to resuscitate the term. Wiener and his collaborators were so impressed with the potency of negative feedback that, with support from the Macy Foundation, they established twice yearly conferences. Initially the conference was known as the Conference for Circular Causal and Feedback Mechanisms in Biological and Social Systems, but after Wiener (1948) coined the term *cybernetics*, the name was changed to the Conference on Cybernetics.

Teleology is an important feature of biological systems, and cyclic organization is important for designing systems that can achieve ends on their own – whether the system is biological or an artifact designed by humans. There is, however, another feature of biological systems that is critical, but that has not received much attention to date by philosophers focusing on mechanism. The ability of mechanisms to function, and especially to regulate themselves, depends critically on the particular ways in which their parts are organized. Being organized, though, is not the natural state of matter. Rather, disorder, or equal distribution, is the state to which physical matter tends. This is the import of the second law of thermodynamics – that in a closed system, entropy (disorder) increases. The only truly stable state, referred to in thermodynamics as the state of maximum entropy, is one in which the components are equally and randomly distributed. When this obtains, the system is at equilibrium.

Given the second law of thermodynamics, biological mechanisms pose a puzzle. As highly organized systems, they are far from thermodynamic equilibrium. According to the second law, this organization should break down and such mechanisms should approach equilibrium. How is it possible to keep a system far from thermodynamic equilibrium – that is, to keep it organized? Part of the answer is that biological systems and their environment are not closed systems; energy is always entering from the outside. However, this energy must be appropriately directed to maintain organization. With human-made mechanisms, the most common means of maintaining organization is to rely on an external repair system, often a human being. Much like the original builder of a mechanism, the repair person utilizes energy, originating outside the system, to reorganize the components when the order between them breaks down and to replace components when they internally break down (become disorganized). In general, however, biological systems do not have external repair people to come in and expend energy to rebuild them. They must do it themselves. How is this possible?

A variety of twentieth-century theorists made important theoretical contributions that provide in basic outline an account of how biological systems

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